#5 Time Series & Data Visualization

by Saturdays.AI

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Machine Learning

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Schedule

State of the course

Session 5 Review

Challenge

Notebook + resources

State of the course

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#1 Cleaning & Exploratory Data Analysis ✔️

#2 Supervised Learning ✔️

#3 Decision Trees & Random Forest ✔️

#4 Unsupervised Learning: Clustering & Dim. Red. ✔️

#5 Time Series Analysis + Data Viz 🔴 Today!

#6 Neural Networks, Gradient Descent 🔜

#7 NLP 🔜

Time Series & Data Visualization

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Time series

- Definitions
- Modeling
    - Components
    - Autocorrelation
    - ARIMA
    - Prediction Intervals
    - B - Plans

Data Visualization

- Small Review
- Tips
- DO NOT's

DEFINITIONS

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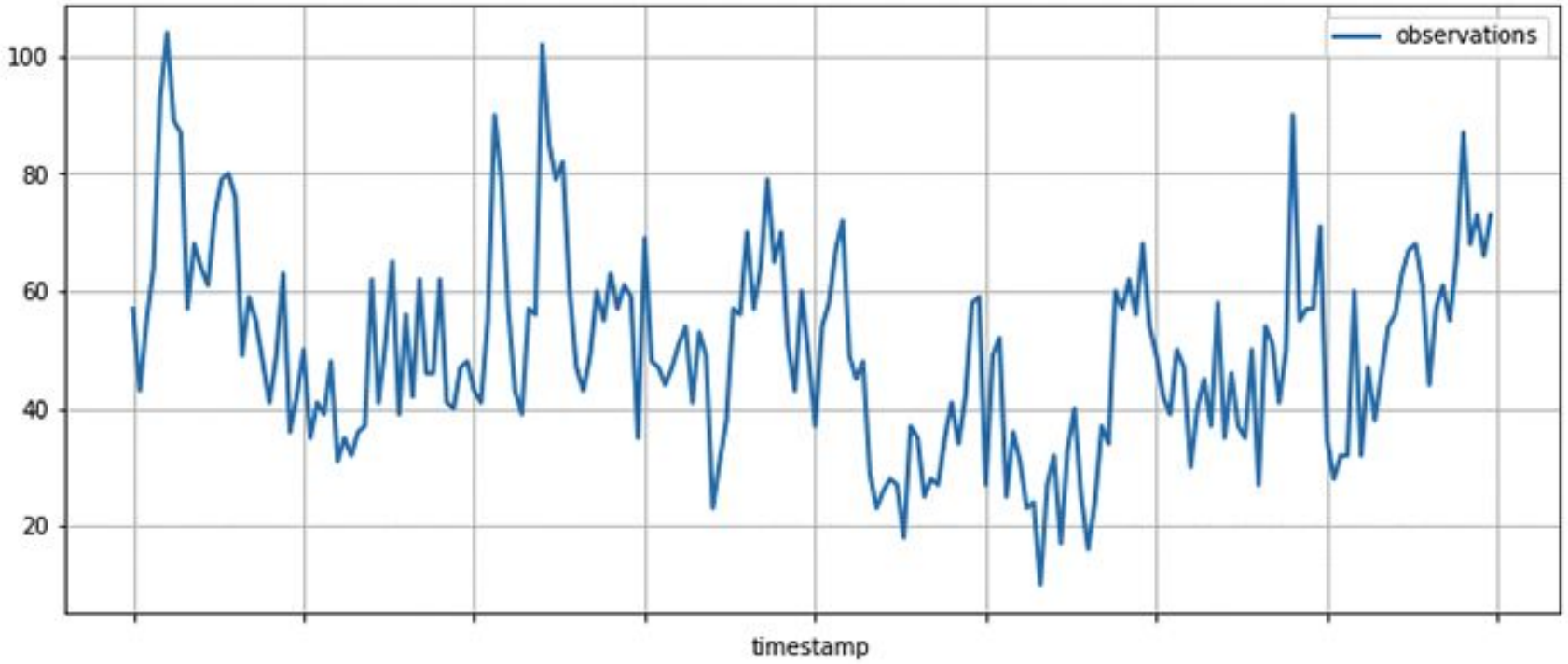

What is a time series

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- **Data points listed in a time order**
- **A sequence is taken at successive equally spaced points**
- **Is a continuous variable**

  - Temperatures, tides, ratios, arrivals …

What is NOT time series

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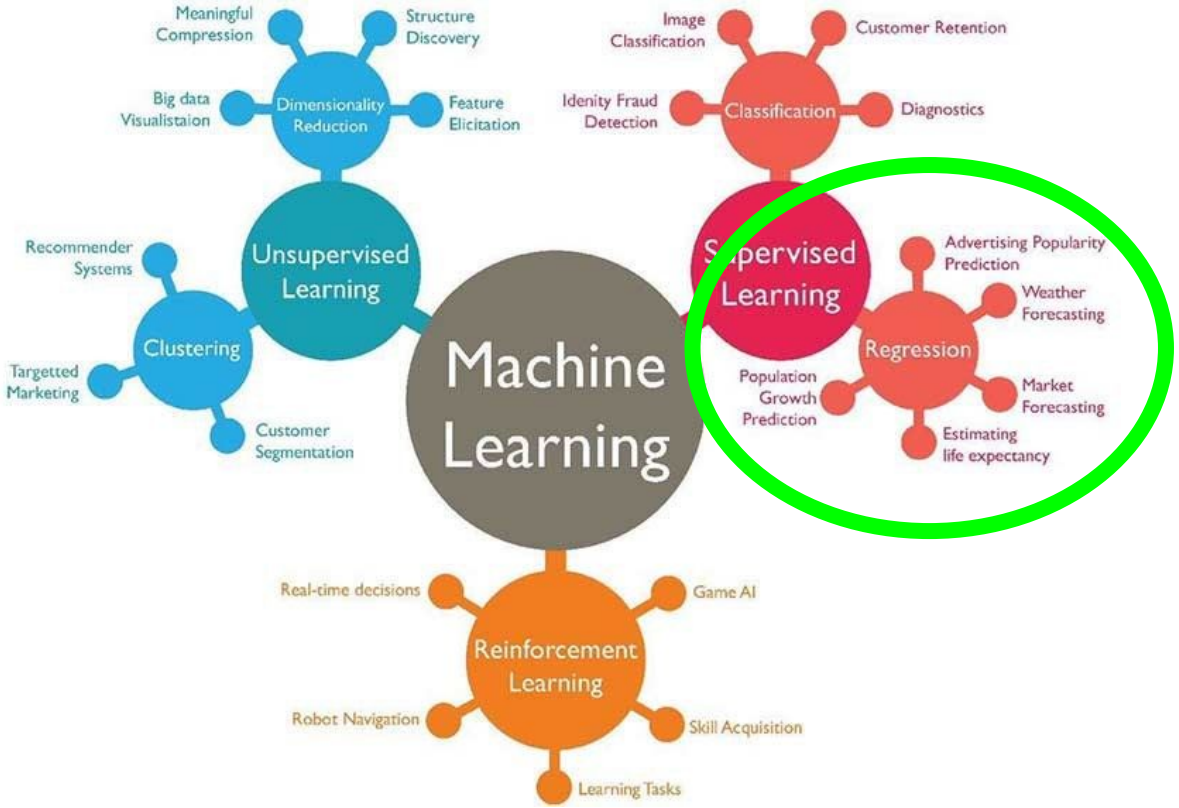
- **Anything that has a timestamp**
  - Some variables can be treated like a time series if EDA is performed, but not all of them
  - Categorical variables: heights
  - Not evenly spaced variables: Counting how many people enter a bar

What should NOT be modeled as a time series



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What is the difference between a Regression and a Time Series

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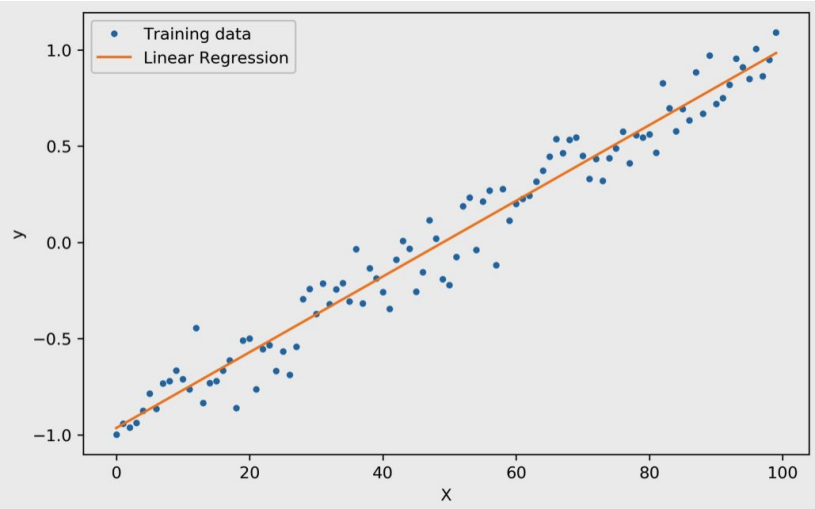
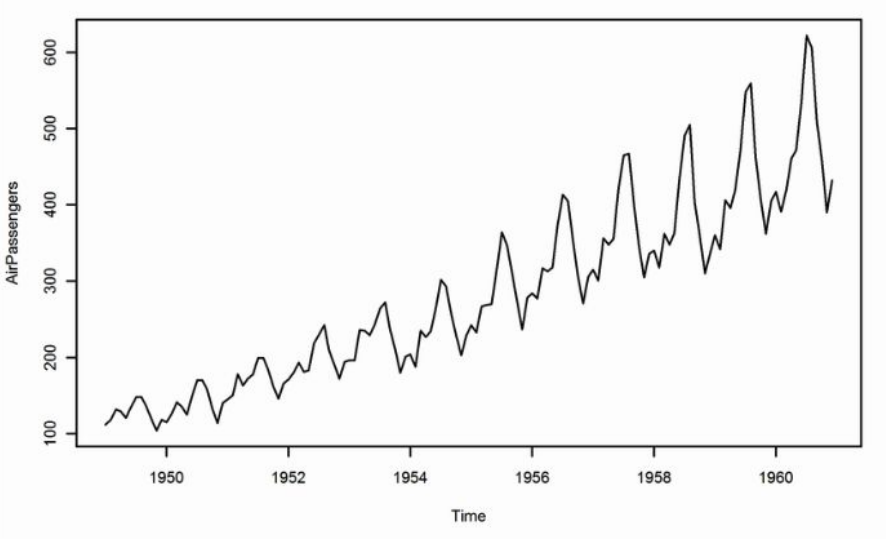
TIME = ORDER

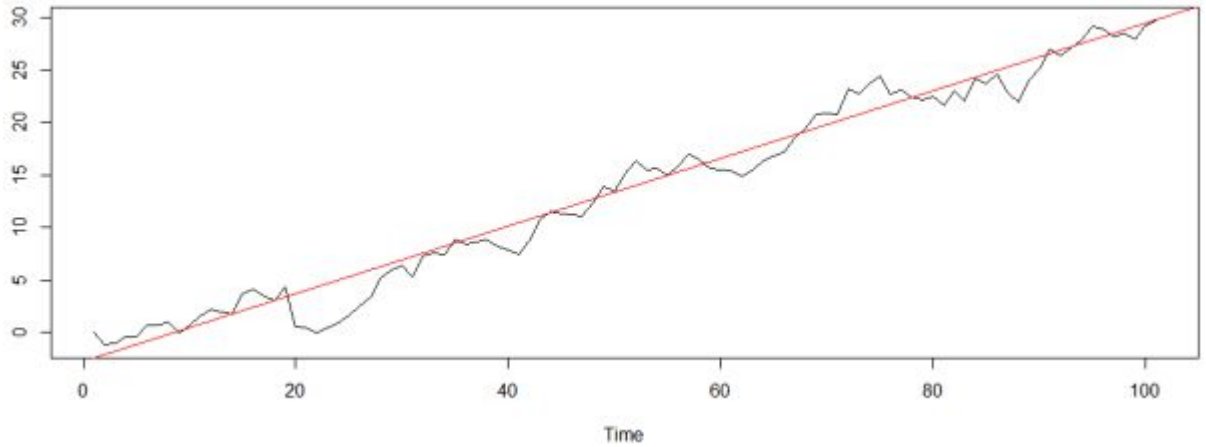




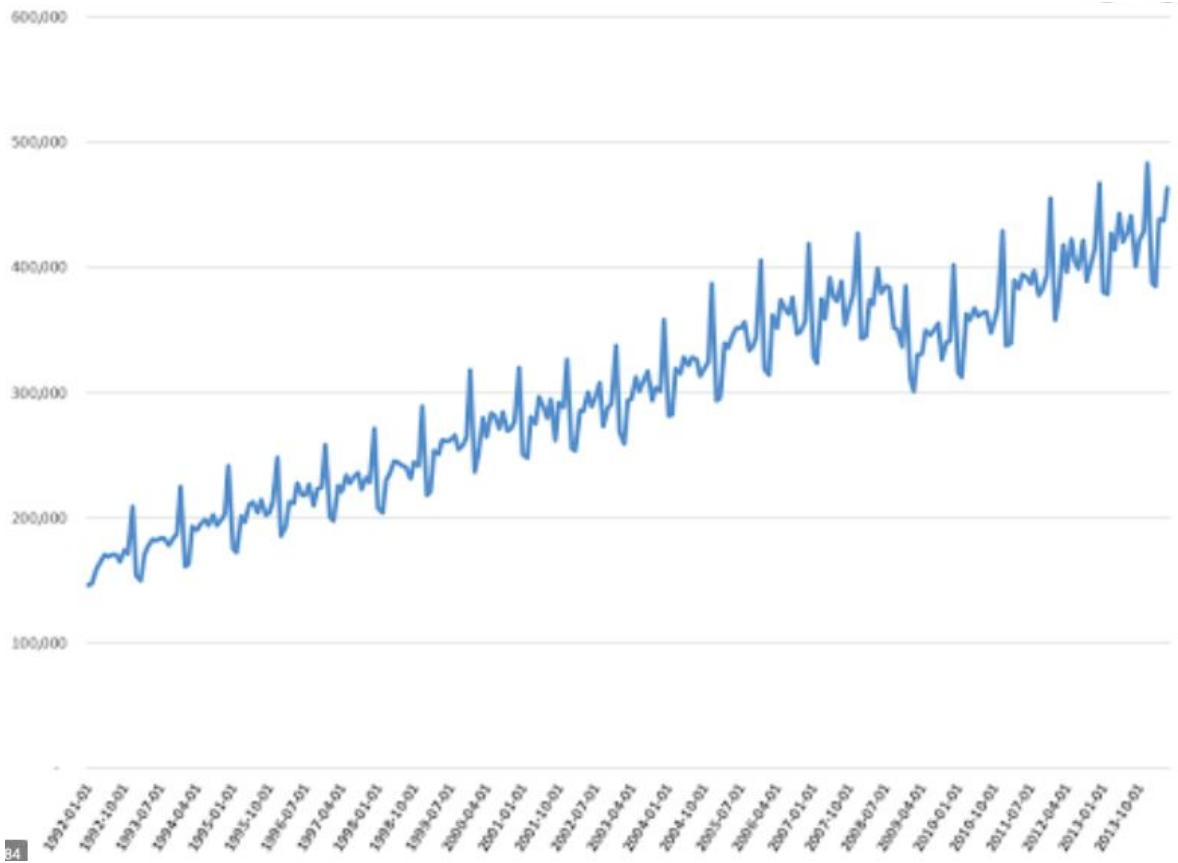
MODELING

Research question
Data validation + cleaning
Exploratory analysis
Modeling phase
Performance

Components: Trend



Components: Seasonality



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Components: Random

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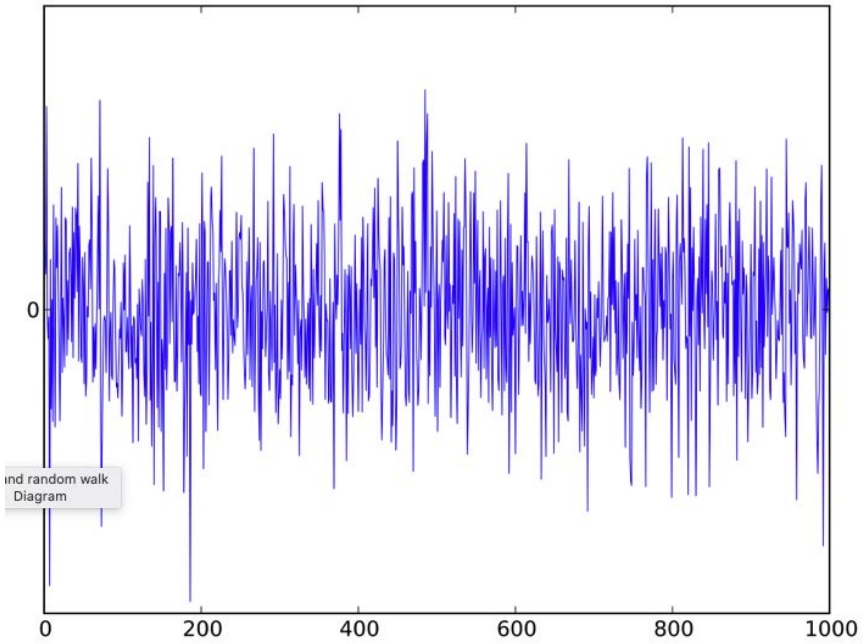
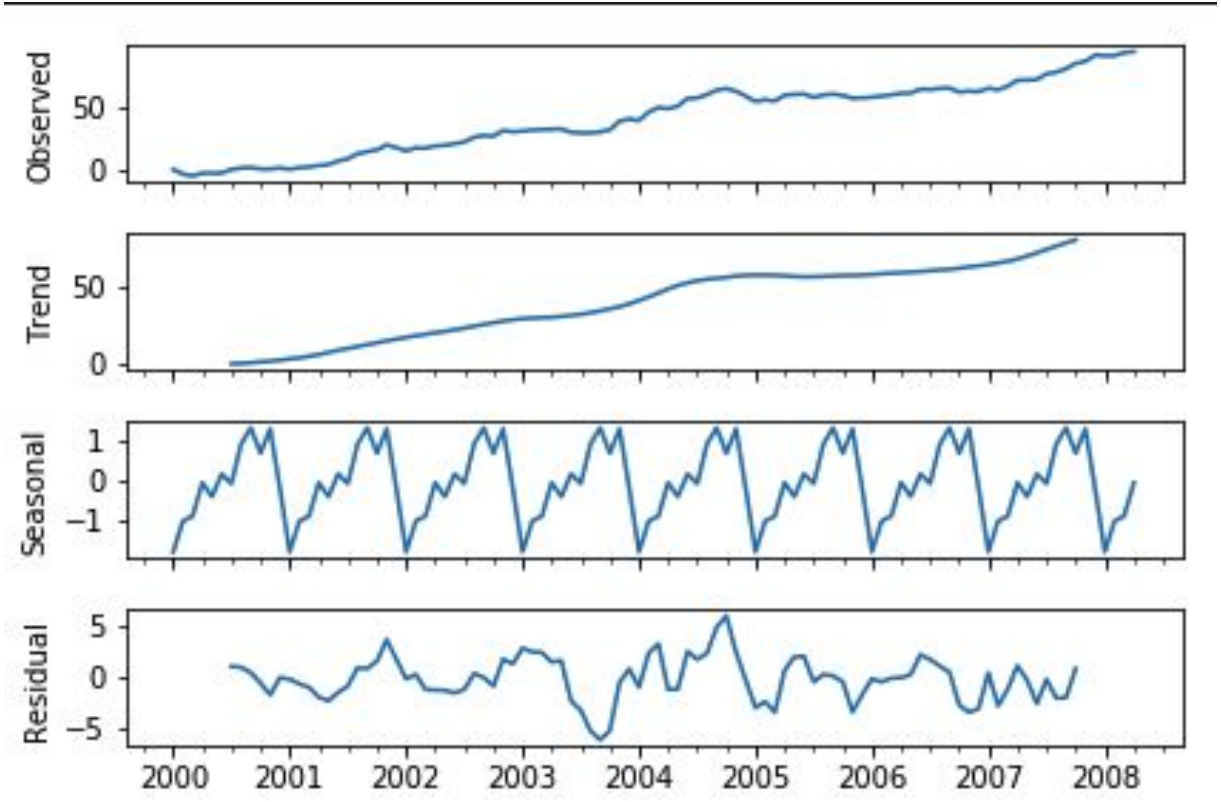
- **White noise**
  - **Random white noise**



Components: Decomposition



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Autocorrelation: Autocorrelation

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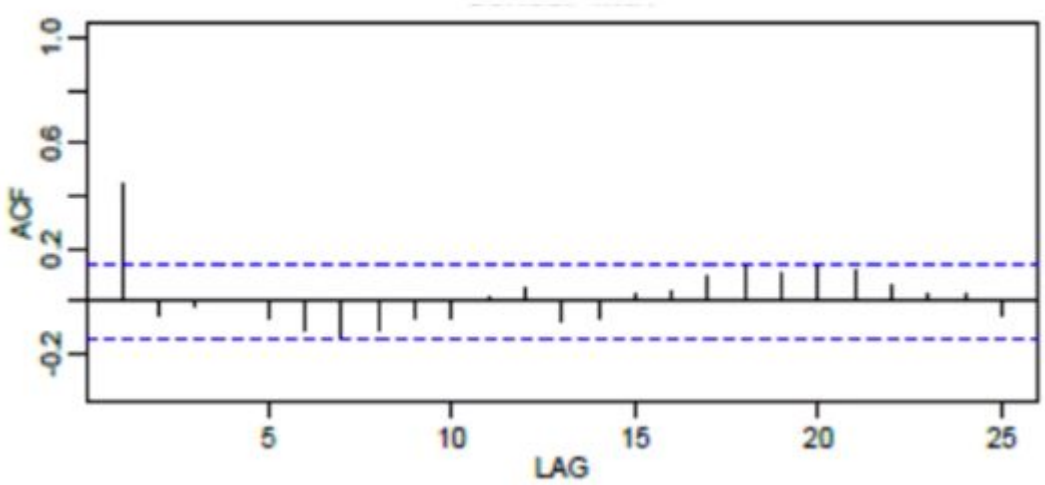
- **The correlation (linear dependence) between one observation and all the previous points in time.**



Autocorrelation: Partial Autocorrelation

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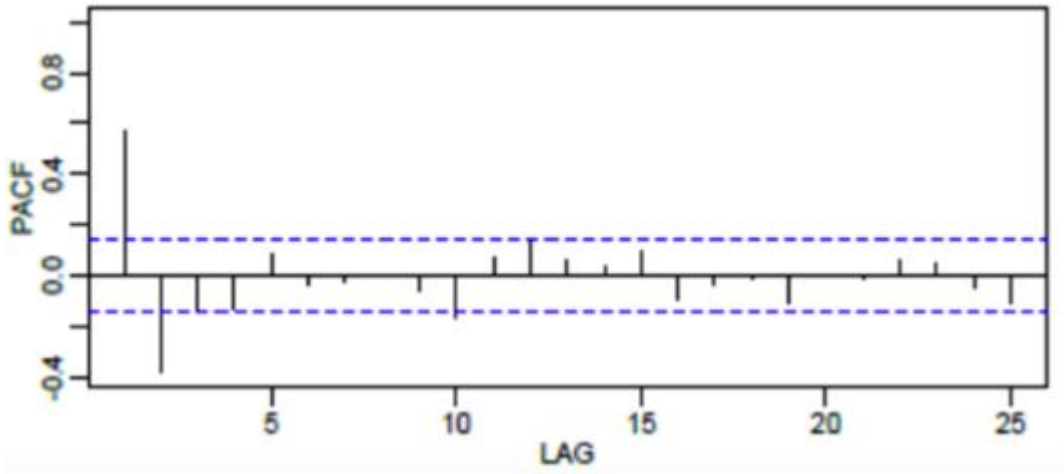
- Correlation between two observations made at different times



Autocorrelation: Stationarity (I)

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Basic assumptions:

- The time series has certain regularity along time
- The time series is stationary (or at least we can transform it to one)

Autocorrelation: Stationarity (II)

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What does it mean to be stationary:

- The mean value of the time series is NOT a function of time.
- The variance is NOT a function of time

- The covariance of a point i and a point i+t, is NOT a function of time

Autocorrelation: Stationarity (III)

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How do we know whether a time series is stationary or not:

- Dickey-Fuller test
  - p-value < 0.05
  - ADF & 1%, 5%, 10%, as close as possible

NO STATIONARY

```
ADF Statistic: 0.8153688792060423
p-value: 0.9918802434376409
Critical Values:
        1%: -3.4816817173418295
        5%: -2.8840418343195267
        10%: -2.578770059171598
```

ARIMA: AR (p)

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- Premise: the past values have an effect on the current values
- The order (p), corresponds to the number of days incorporated on the formula.
- We can get (p) from the partial autocorrelations

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t-2} + \beta_3 y_{t-3} + \cdots + \beta_p y_{t-p}$$

ARIMA: MA(q)

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- Value of the current day, depends on the errors of the past days
- q is the number of terms to be included
- The Autocorrelation function helps to get the best (q) parameter

$$y_t = \varepsilon_t + \alpha_1 \varepsilon_{t-1} + \alpha_2 \varepsilon_{t-2} + \cdots + \alpha_q \varepsilon_{t-q}$$

ARIMA: ARMA(p, q)

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- Adds the two models seen before = AR + MA

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t-2} + \beta_3 y_{t-3} + \cdots + \beta_p y_{t-p} + \varepsilon_t + \alpha_1 \varepsilon_{t-1} + \alpha_2 \varepsilon_{t-2} + \cdots + \alpha_q \varepsilon_{t-q}$$

ARIMA: (p, d, q)

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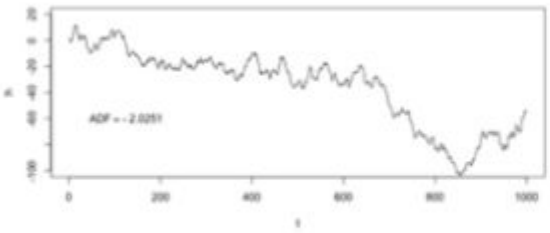
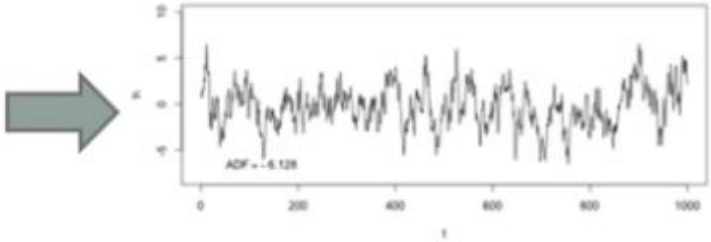
- Adds a (d) differencing component to ARMA
- Differencing subtracts the current value from the previous.
- It can be used to transform a time series into one that is stationary



Data with trend



Data after one-lag differencing

Prediction Intervals

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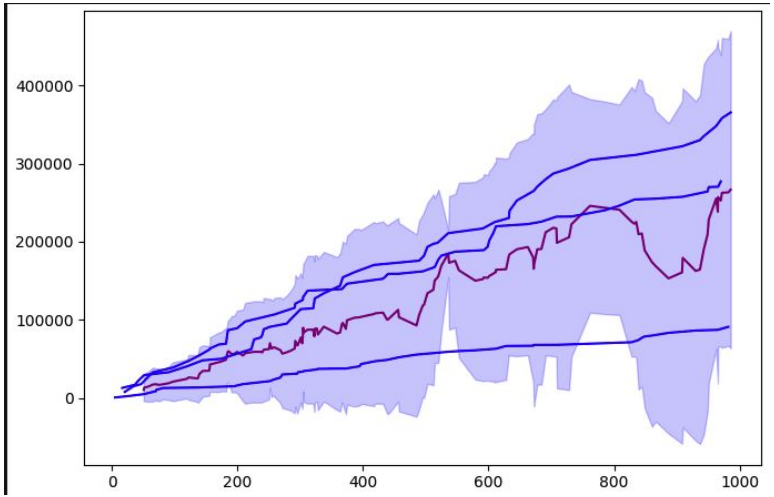
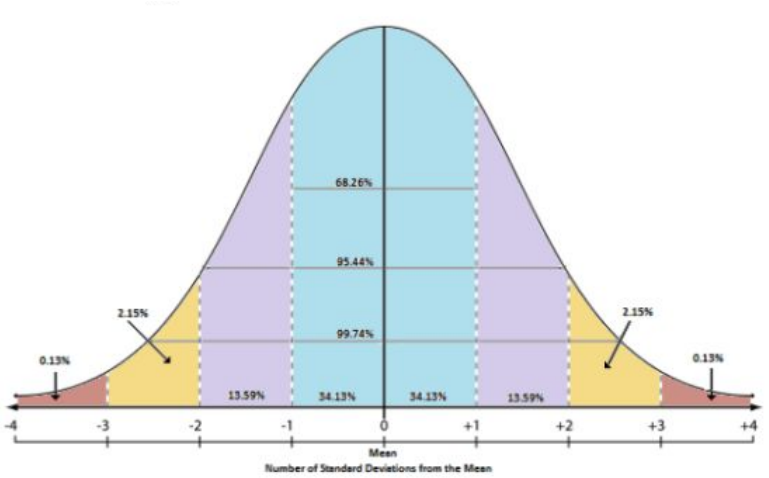
Rolling means and standard deviation



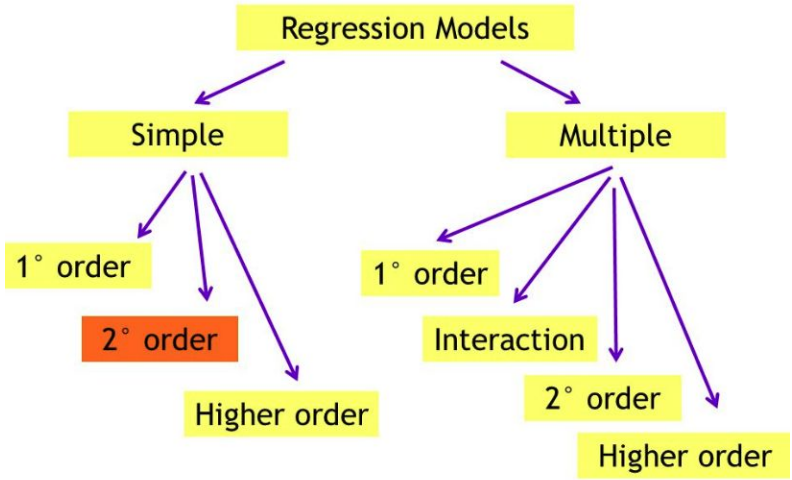


Source: deltanalytics.org

B-Plan : Diagram

1. Is our data a Time series?
2. Is it stationary? Can we transform it to stationary?

If we get a no...



SMALL REVIEW

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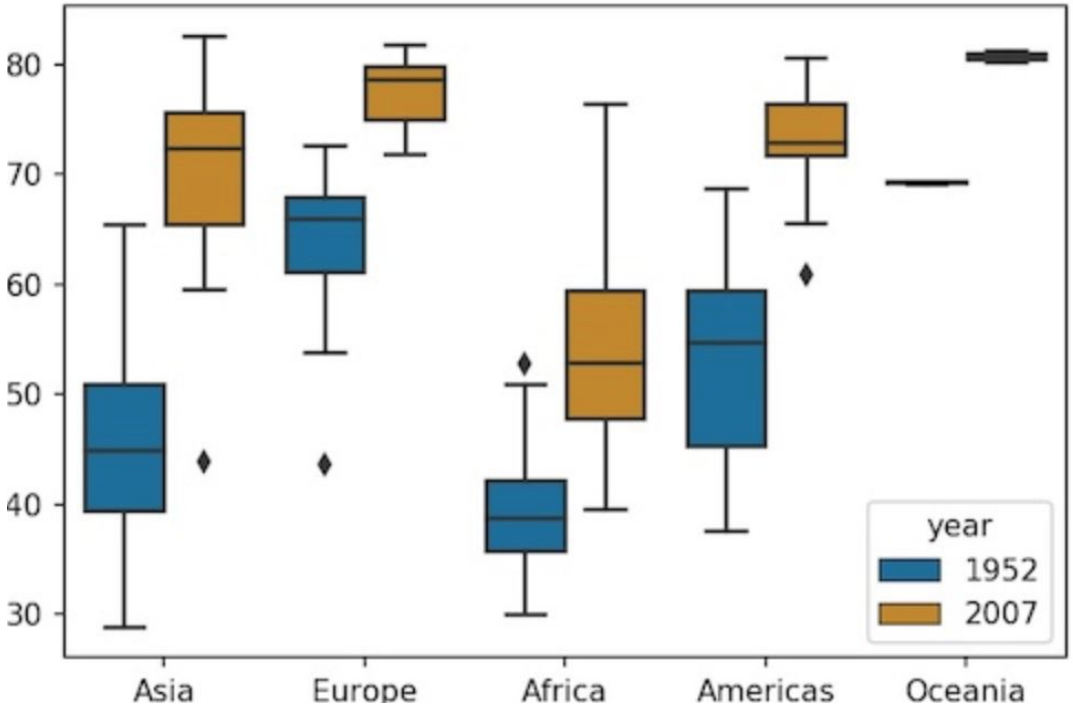
SMALL REVIEW: Boxplot



SMALL REVIEW: Violin Plot

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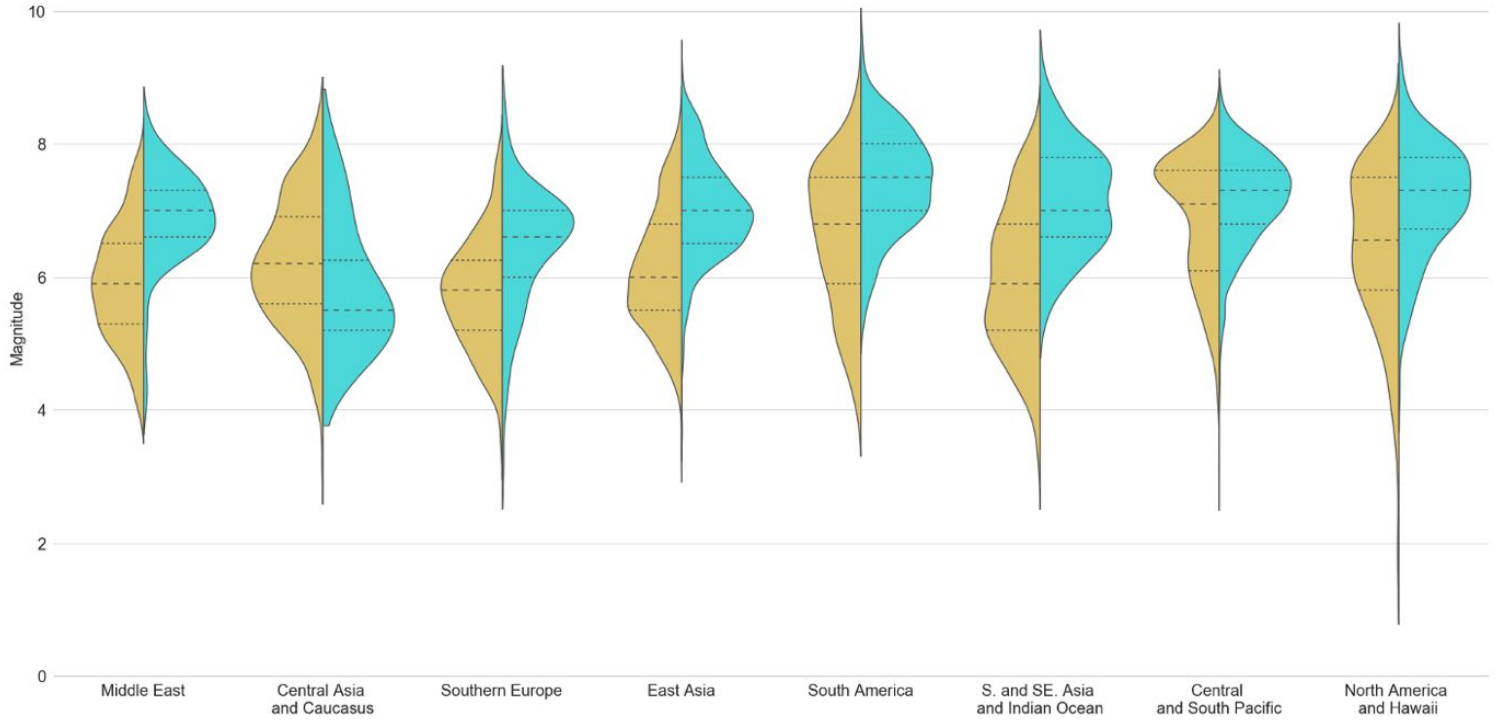
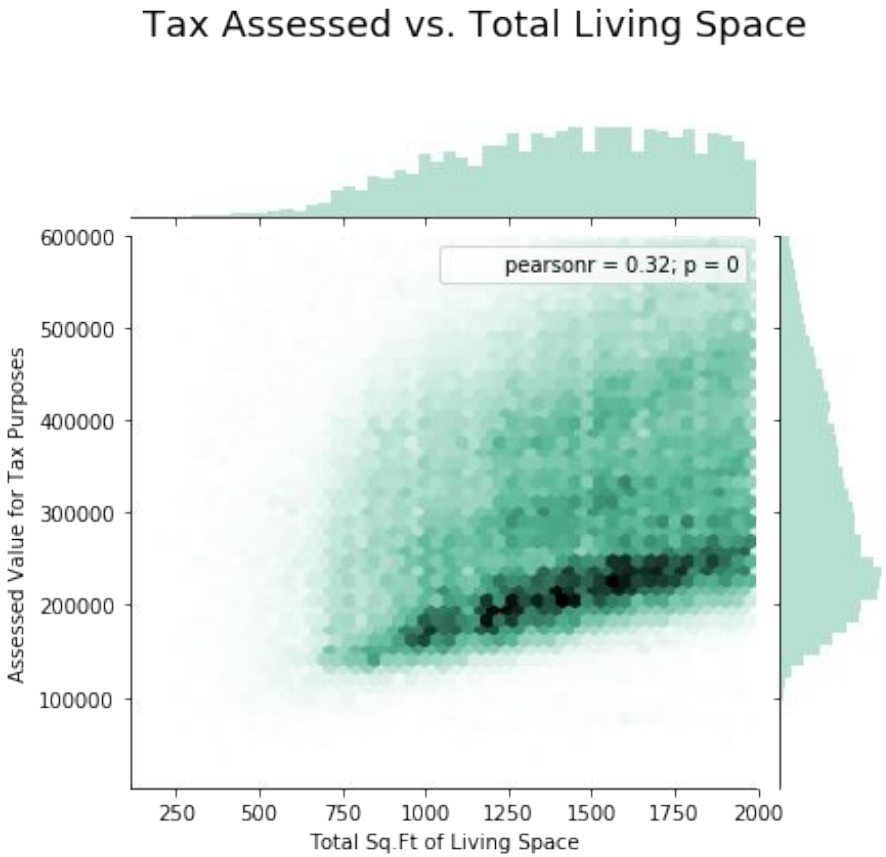


SMALL REVIEW: Hexagonal Binning



TIPS

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TIPS

1. Scale
2. Color Code
3. Axis
4. Units
5. Title
6. 0 **MUST APPEAR**

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TIPS

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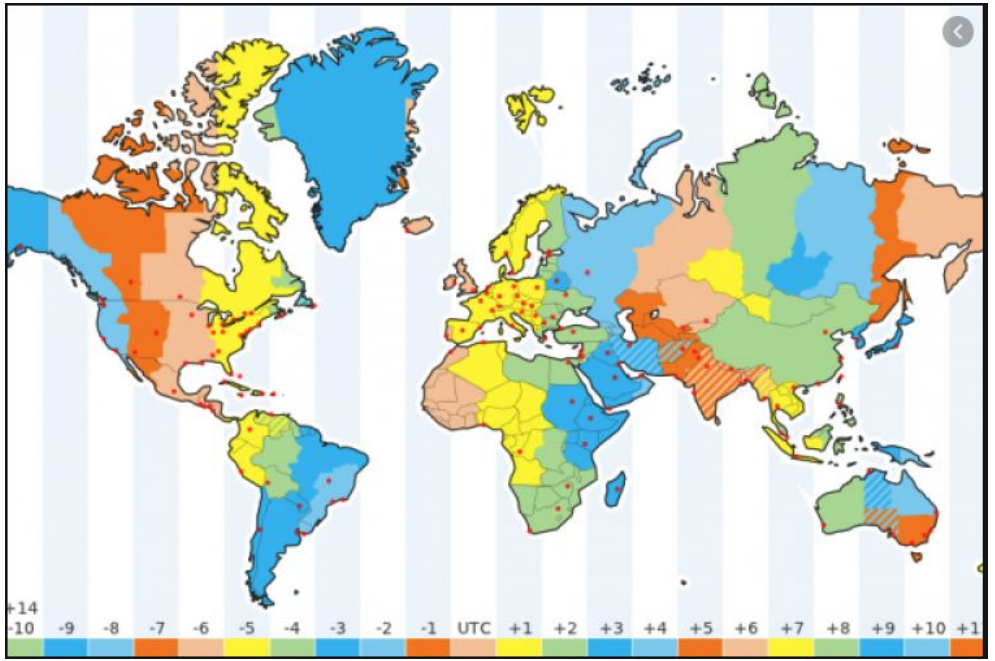
Timestamp:

- Milliseconds since 01/01/1970
- Keep an eye on Timezones
  - Winter/Summer



TIPS

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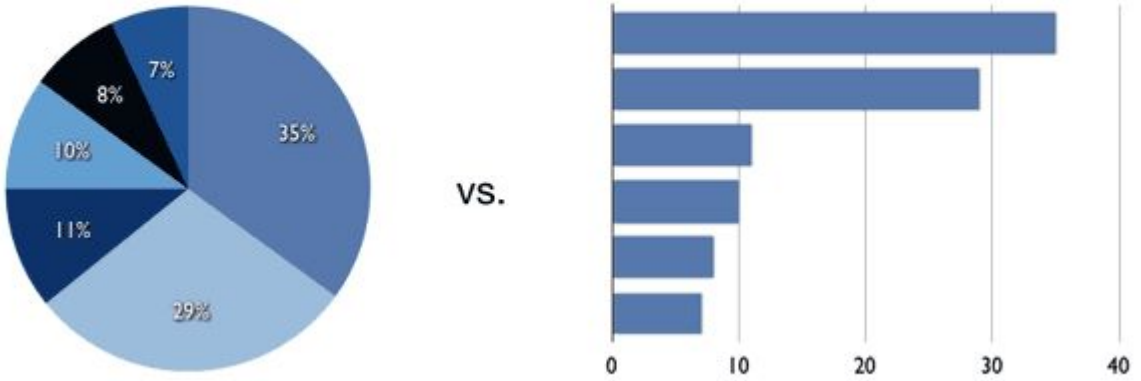
Pie Chart Vs. Bar Graph



DO NOTS

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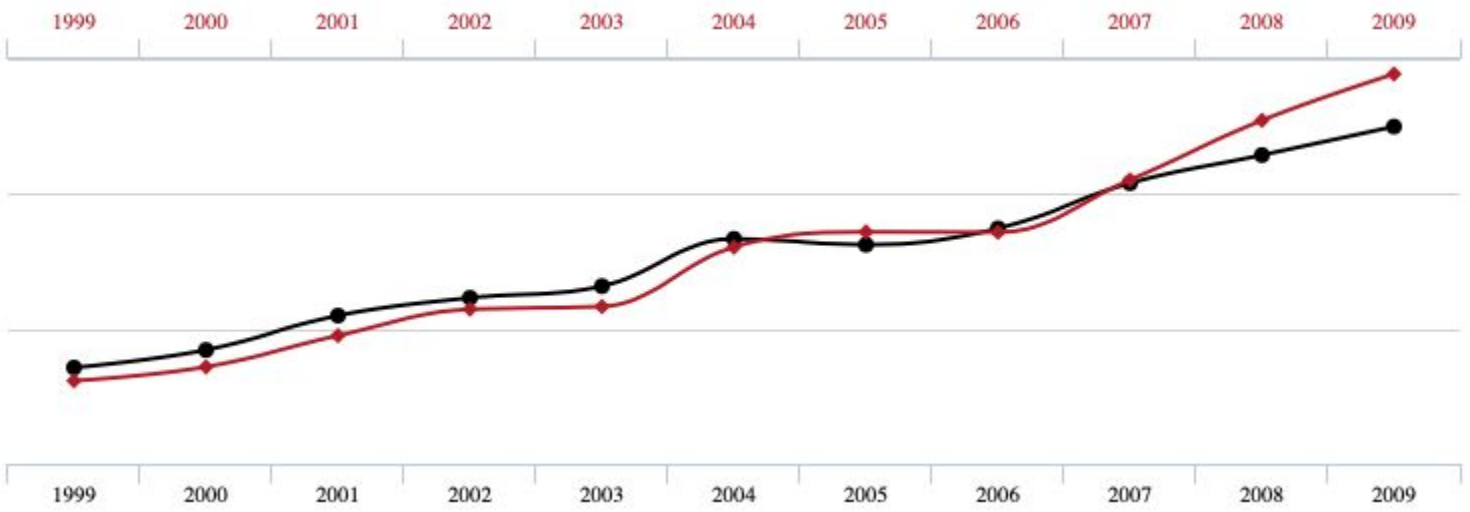
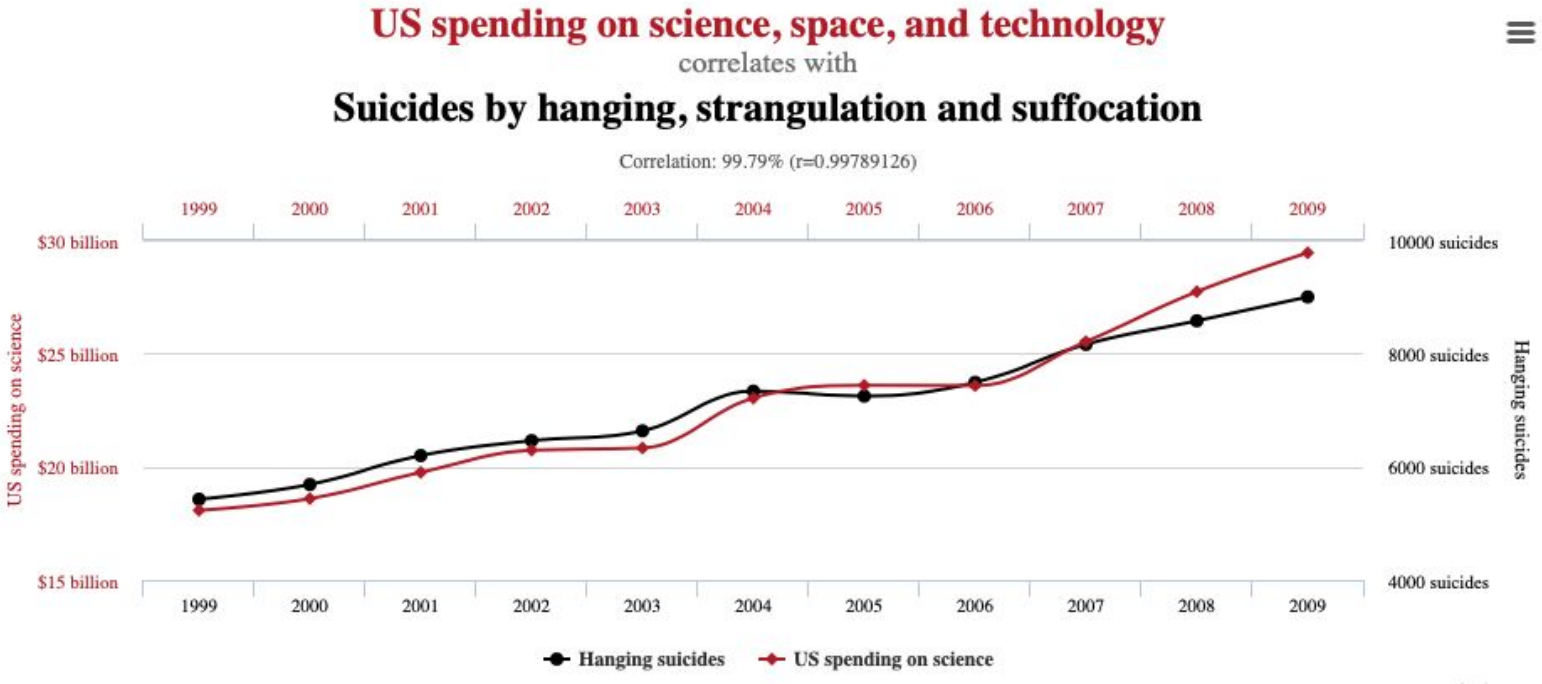
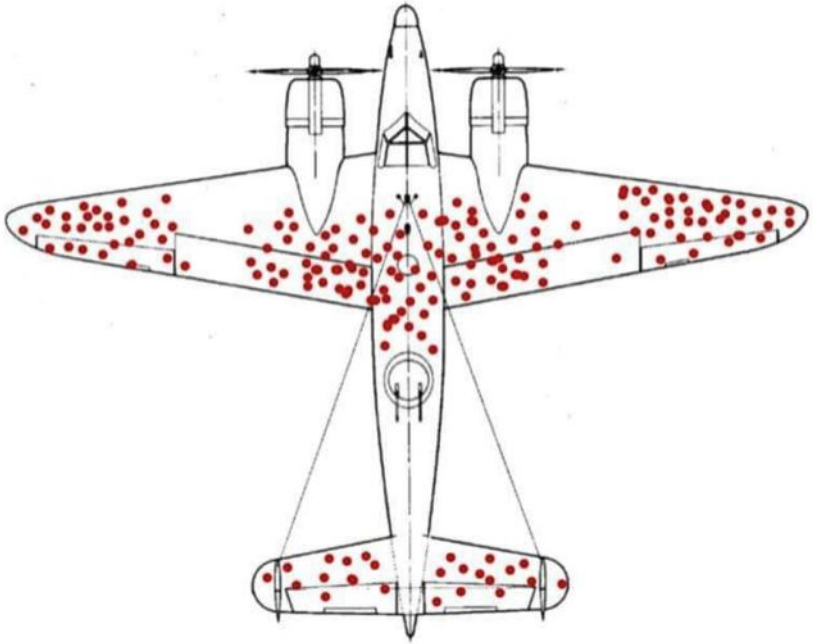
DO NOTS: Common mistakes I



DO NOTS: Common mistakes II



DO NOTS: Common mistakes III



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DO NOTS: Common mistakes IV

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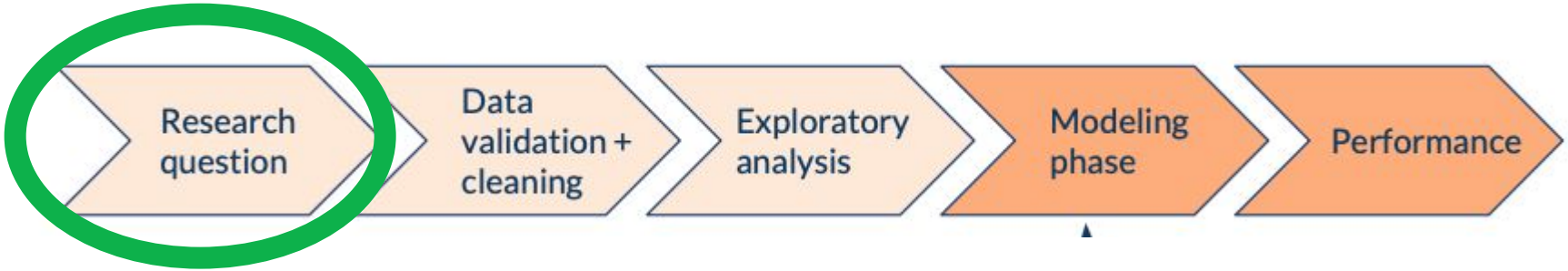
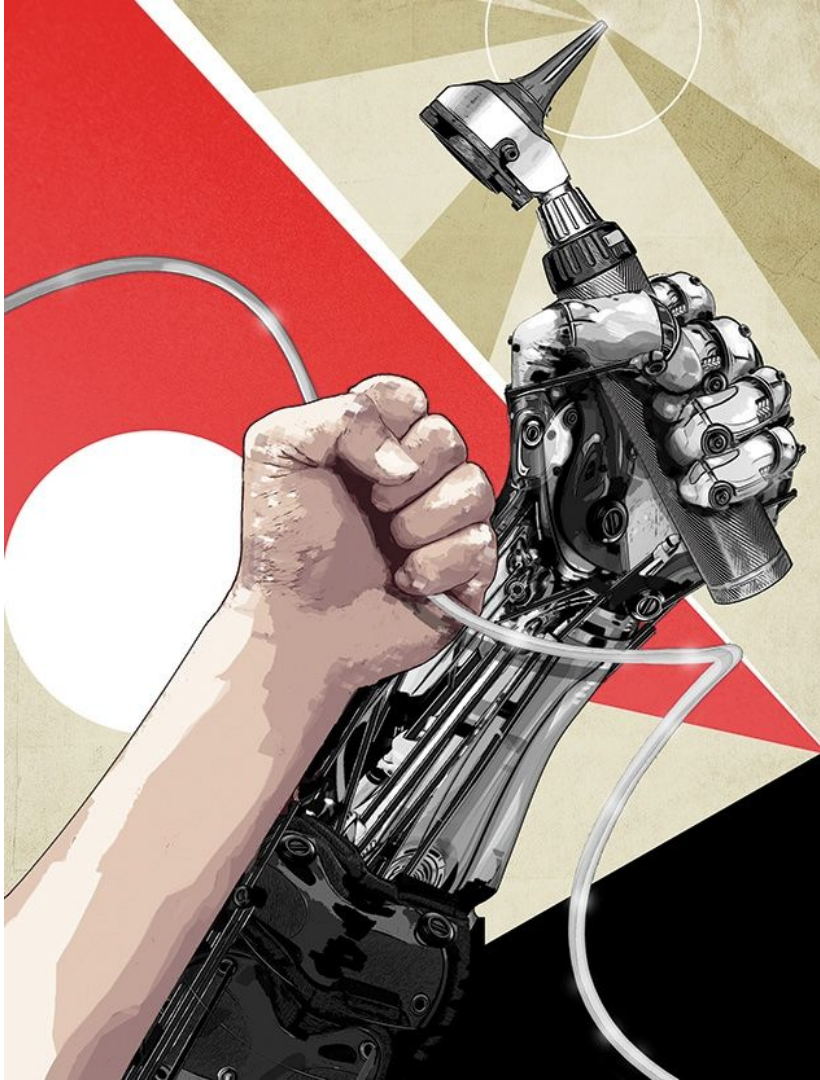
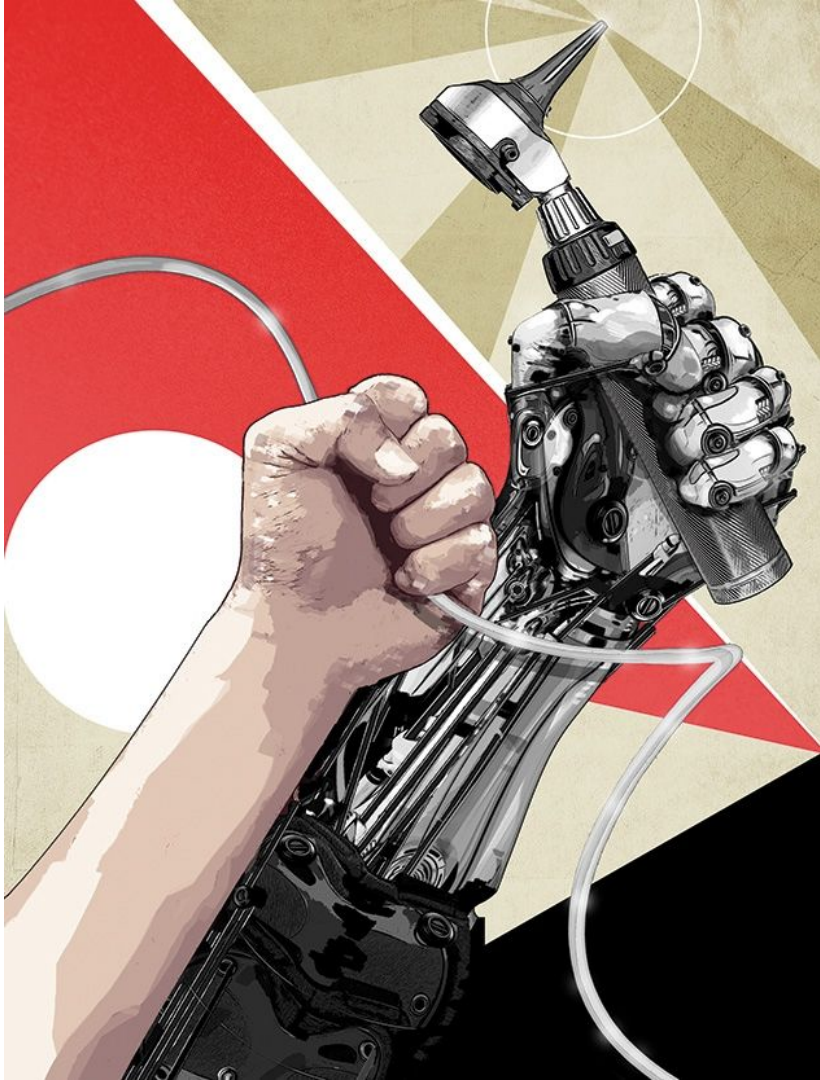


Practice - Time Series!



Challenge - Time Series!



Bibliografía

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/1./ /Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow/

/2./ /Fast.AI - Introduction to Machine Learning for Coders/

/3./ /MLCourse.AI/

/4./ /DeltaAnalytics/

/5./ /The Hundred-page Machine Learning Book/

/6./ /Machine Learning for Humans (Vishal Maini)/

/7./ /Datacamp/

/8./ /DataQuest/

Partners

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Agradecemos a nuestros partners por confiar en nosotros para facilitar la formación en IA de cara a la 4ª Revolución Industrial.

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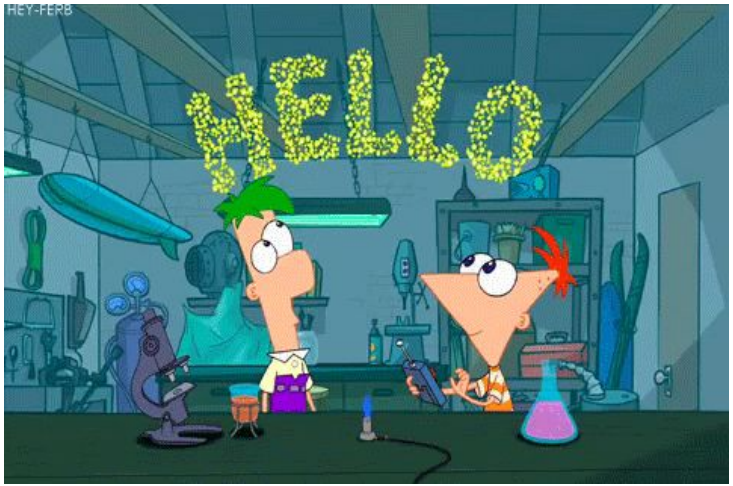

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This model fits me
95% of the time

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